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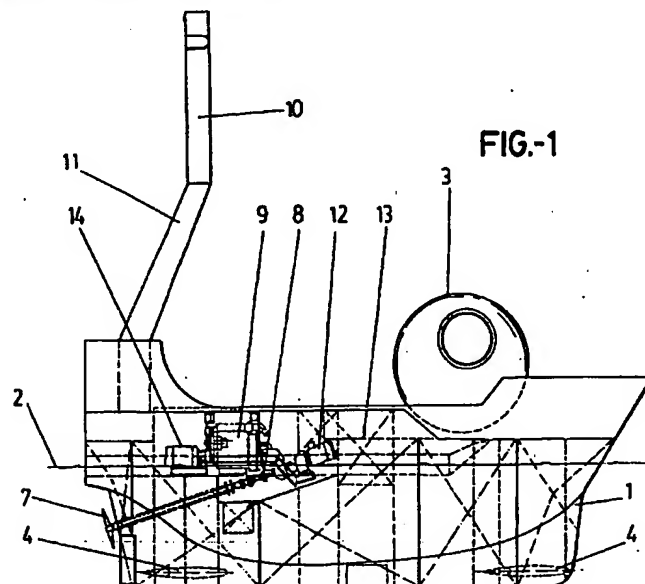
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**(54) SUBMERSIBLE BOAT**

(57) Submersible boat is capable of navigating both on the water surface and submerged, the diving taking place by dynamic effect when the operator requires it, the boat having a catamaran type structure, comprising two side floats (1-1') which are maintained partially under the water-line (2), while its cabin (3) is kept totally above said water-line when the boat navigates at the water surface. Fins (4) situated between the floats (1) provide for

the steerability of the boat, both submerged and at the water surface, while the thrust is generated by a pair of propellers situated at the lower end of the floats (1) and actuated by diesel engines (9) when the boat navigates on top of the water or is submerged in shallow waters, but in deep waters the engines (9) are substituted by electric motors (12) supplied by batteries (13).



**FIG.-1**

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## Description

### OBJECT OF THE INVENTION

The present invention relates to a submersible boat, in other words an aquatic vehicle capable of navigating both on the water surface and submerged and therefore, in addition to offering a performance similar to that of a conventional submarine, when used as a surface boat, its cabin for occupants lies entirely above the water as a classic boat.

### BACKGROUND OF THE INVENTION

The very applicants hold a patent 8703322 disclosing a two-level mobile land-sea crawler capable of travelling on both dry land and in water, and when in water both on the surface and submerged, a fundamental characteristic in the latter respect being that diving was achieved dynamically with the assistance of fins which were suitably directed to force the mobile vehicle to dive due to its forward speed.

Whilst perfectly valid from a theoretical viewpoint, the solution used was in practice inconvenient in a number of ways, inter alia as follows:

The fact that the mobile vehicle is capable of diving only dynamically prevents the body from remaining static underwater, which could often be interesting or necessary.

The dynamic diving effect as such means that the diving effort required is substantial and that the energy consumed in so diving is therefore also substantial.

The very presence of the fins used to steer the mobile vehicle, projecting sideways from the same, poses difficulties.

Lastly, having been conceived as a vehicle capable of travelling on dry land, the mobile vehicle has a number of structural and design limitations that are far more significant than the scarce advantages derived from such possibility, for use of the mobile vehicle to travel on land is expected to be scarce, almost negligible, as compared with its use in water.

### DESCRIPTION OF THE INVENTION

Bearing in mind the above, the submersible boat subject of the present invention has been deprived of the possibility of travelling on land which has concurrently considerably enhanced its performance over that of the mobile vehicle subject of patent 8703322.

More specifically, in order to achieve the above, and in accordance with one of the characteristics of the invention, the submersible boat is structured as a submersible catamaran and therefore when it navigates as a surface boat, the cabin for occupants lies entirely above water, as on a conventional catamaran, and unlike conventional submarines where the cabin for occupants is submerged at all times, even when it does not navigate underwater.

In accordance with another characteristic of the invention, the two side floats of the boat which support the cabin aforesaid not only serve such purpose and house certain of the boat's accessories, as described further on, but carry a number of ballast tanks serving a twofold purpose, namely on the one hand approximating the boat's buoyancy rate to almost zero at the time of diving and thereby expediting this operation, in other words enabling diving to be quicker and dynamic, and on the other hand suitably increasing the ballast after the dive in order that the boat may stop its forward travel and remain stable at the selected depth.

In accordance with another characteristic of the invention, the boat steering fins are arranged between and below its two floats, which expedites docking operations since they do not constitute prominent members with respect to the overall geometry of the boat. These fins have moreover been designed to be laterally split into two halves in order not only to allow the boat to be controlled during dynamic diving and rising but further to serve as members controlling rolling and pitching.

Other characteristics of the invention lie in the boat's propulsion system, cooling system, ballast system, emergency and service pneumatic system and steering system as detailed hereinafter and in accordance with the contents of the attached set of claims.

### DESCRIPTION OF THE DRAWINGS

In order to provide a fuller description and contribute to the complete understanding of the characteristics of this invention, a set of drawings is attached to the specification which, while purely illustrative and not fully comprehensive, shows the following:

Figure 1.- Is a schematic side elevation drawing of a submersible boat constructed in accordance with the object of the present invention.

Figure 2.- Is a plan view thereof.

Figure 3.- Is a front elevation view.

Figure 4.- Is an enlarged profile detail of one of the fins.

Figure 5.- Is a plan view of the fin of the previous figure.

Figure 6.- Is a diagram of the propulsion unit.

Figure 7.- Is a diagram of the ballast system.

Figure 8.- Is a diagram of the emergency and service pneumatic system.

Figure 9.- Is a schematic perspective drawing of the boat's floats where the various members of the control system have been schematically distributed.

Figure 10.- Is a schematic front elevation drawing of the control board from which the boat is steered.

Figure 11.- Is lastly a general diagram of the system for controlling the boat.

The layout and characteristics of the various systems and components of the submersible boat can be varied in accordance with the technological developments fitted thereon, for this does not encumber the basic notion of the invention and the claims set forth in this patent.

### PREFERRED EMBODIMENT OF THE INVENTION

With reference to the figures, the submersible boat disclosed herein is shown to have a general catamaran type structure comprising two side floats (1-1') which are maintained partially under the water-line (2) of the boat, a cabin for occupants (3), whose shape may be substantially cylindrical as shown in figures 1 to 3 or otherwise howsoever as thought proper, being established on the floats (1), the cabin (3) being kept totally above the water-line (2) when the boat navigates on the water and obviously being submerged when the boat navigates underwater.

Diving takes place dynamically, with the assistance of fins (4) which are shown, in particular in figure 1, to lie between and below the floats (1-1'). The fins (4), whose structure is shown in detail in figures 4 and 5, having a hydrodynamic profile, are split lengthwise into three sectors, a horizontal fixed sector actually marked (4) and two articulated sectors (5) and (6) which may be moved both upwards and downwards, as shown in figure 4, to achieve a diving or rising effect, in other words whichever is desired from time to time and at all events based upon the relative displacement between such fins (4) and the water.

Furthermore, and as shown in figure 5, the rear and articulated sector (5-6) of each fin (4) is laterally split into two halves (5-5') and (6-6') thereby for an asymmetry on the pivoting side of such fins or between the bow and stern fins to originate a compensating effect for the boat's balancing and pitching movements.

The boat is propelled by two propellers (7) arranged at the rear end of its floats (1-1'), the propellers receiving the drive of a diesel engine (9) through a gearing (8) when navigating on the water or submerged at little depth, less than 2 or 3 metres, the snorkel or funnel (10) being used as a means for drawing air in and letting off gases to and from each diesel engine (9), the funnel (10) being structured with a forked shape thereby for its output branch, actually marked (10), to have two branches (11-11') associated leading from the respective diesel engines (9), as in the patent above-mentioned, whereas when the boat is submerged beyond the depth aforesaid the diesel engines (9) are stopped and replaced by respective electric motors (12) supplied from a set of batteries (13) which are previously charged by the diesel

engine (9) proper through an alternator (14) fitted with a rectifier (15) and a frequency regulator (16), thereby for the various components of the boat consuming direct current (19) and alternating current (20), referred to hereinafter, to be supplied by two switchboards (17) and (18), respectively providing direct and alternating current. The batteries may also be charged using external power supplies.

As noted hereinabove, diving is expedited by a ballast system schematically shown in figure 7, which comprises a self-drawing seawater centrifugal electropump (21) which supplies and removes water to and from a number of balance tanks (22) and ballast tanks (23) through a number of pneumatically actuated valves (24).

Figure 8 shows the emergency pneumatic and service system comprising a plurality of air cylinders (25), which are mounted upon respective stands (26), are fitted with pressure regulating means and are fed through a compressor head (27) coupled to one of the engines (9), and feed and supply air to atmospheric valves, bottom valves and pressure compensating valves, cylinders actuating the rudders, the fins, the valves shutting off the snorkel tubes (10) and (11), the diesel engine accelerator cylinders, the engine gear cylinders and the electrovalves controlling the foregoing elements, as shown schematically in figure 8 aforesaid.

As shown schematically in figure 9, the control system is structured with pressure sensors (28), depth sensors (29), said ballast system electrovalves (30), pneumatic system electrovalves (31), cabin gas analyzers (32), a cabin temperature and relative humidity sensor (33), fin load cells (34), inclinometers (35) and computers (36), the latter situated at the cabin, specifically on the control board (37) shown in figure 10, moreover fitted with a radio communication system (38), a video circuit (39), a satellite position system (40), a sounder (41), a steering-wheel (42) and the necessary boat speed and steering and depth levers (43) and (44). An alarm unit (45) automatically flags any anomaly.

From a functional viewpoint, the boat control system is responsible for the operation of the various systems and continuously receives data from all the sensors fitted aboard the boat, sending out commands to all actuators.

The control system is programmed such that the boat operator needs no controls other than as mentioned hereinabove, in other words the steering-wheel or helm (42), a depth lever (44), a speed lever (43) and a switch to select the desired navigation status, although the operator may operate others that are not as essential.

The general diagram of the control system of figure 11 clearly shows system operation, the number references therein standing for the following items:

- 46 Master cabin computer.
- 47 Cabin sensor data.
- 48 Operator interface.
- 49 Current sensor and actuator values.
- 50 Actuator reference values.
- 51 Engineer room slave computer.

- 52 Sensor data.
- 53 Actuator commands.

Now the control system therefore comprises a slave computer (51) located at the engineroom and designed to receive data (52) from the sensors and send appropriate commands (53) to actuators, and a master computer (46) responsible for making control calculations, sending the slave computer (51) actuating commands and supporting the boat operator communication interface (48).

The main characteristics of this system primarily lie in the following:

- Physical components (hardware) comprising standard compatible commercial cards.
- Structured programming.
- Easy maintenance and inspection, including the boat's operating statistic record.
- Highly reliable hardware and software.

The structure disclosed is additionally fitted with an emergency system based upon the principle of intrinsic safety by maintaining a compensated positive buoyancy in normal navigation and by reverse dynamic lift at the fins (4), provision being made for the tanks to have emergency unballasting, the possibility of detaching the cabin, the possibility of lifting the vehicle through eyebolts, the possibility of pressurizing the cabin to open the door and exit, and lastly radio communication with the outside through a communications buoy or through underwater communications systems.

We feel that the description need not be extended any longer for anyone skilled in the art to have grasped the full scope of the invention and the advantages it offers.

The materials, shape, size and layout of the elements may be altered provided that this entails no modification of the essential features of the invention.

The terms used to describe the invention herein should be taken to have a broad rather than a restrictive meaning.

## Claims

1. A submersible boat, being of the kind in which diving takes place dynamically, in other words by action of the thrusting strength of the engines and due to the leading angle of a set of fins in the water, essentially characterised because whereas its floating means (1) carrying ballast tanks (22-23) are kept permanently at least partially below the water-line (2), the cabin or compartment for occupants (3), which in the submerged situation is obviously also below the water-line (2), lies totally above said water-line (2) when the boat is on the surface.

2. A submersible boat as in claim 1, characterised because the boat resembles a catamaran in shape and has two lateral floating bodies (1-1') upon and above which lies the cabin for occupants (3), substantially raised above the water-line (2) defined for the boat as a whole, and being especially particular in that the fins (4) for steering the boat lie between and below the side floats (1-1').

3. A submersible boat as in preceding claims, characterised because each fin (4), having a generally aerodynamic profile, is provided with a front, major and fixed sector whose rear edge is articulately fitted with two other sectors (5) and (6) making up deflecting means for diving or rising of the boat, the rear articulated sectors (5) and (6) on each such fin (4) being designed to be laterally split into two equal separately actuated halves, thereby for the asymmetric position of the two halves (5-6) and (5'-6') of the fin to cause the fin to further serve as a boat control system insofar as rolling and pitching movements are concerned.

4. A submersible boat as in preceding claims, characterised because the boat propelling means are two propellers (7) emerging at the rear end of its floats (1-1'), each being driven by a diesel engine (9) through a gearing (8) when the boat navigates on the water or submerged at little depth, and by an electric motor (12) when the boat navigates submerged at a greater depth, said diesel engine (9) being fitted with a funnel (10-11) leading into the atmosphere, which draws air and lets off gases to and from the diesel engines (9), one of said engines (9) being designed to actuate an alternator (14) that charges a set of batteries (13) which power the electric motors (12) through a rectifier (15), this circuit including a double switchboard (17-18) supplying direct and alternating current to the various apparatus and instruments on the boat consuming either current. Propulsion may also be actuated otherwise howsoever.

5. A submersible boat as in preceding claims, characterised because the boat includes a self-drawing centrifugal electropump (21) capable of sending seawater towards a number of balance tanks (22) and (23), and of removing the water from such tanks, the ballast tanks and the engineroom wells, with the assistance of a set of pneumatically actuated valves (24).

6. A submersible boat as in preceding claims, characterised because the boat moreover includes an emergency and service pneumatic system comprising a plurality of air cylinders (25) mounted on stands (26) which are assisted by a filling compressor head (27) actuated by one of the main diesel engines (9), thereby for the compressed air within such cylinders

(25) to be used through suitable valves to actuate the cylinders of the rudders and fins (4), the shut-off valve for funnels (11-11') and the engine accelerator cylinders, all from the control board (37) located at the cabin (3) on the boat and through the control system central computer. 5

7. A submersible boat as in preceding claims, characterised because the boat control system includes pressure sensors (28), depth sensors (29), ballast system electrovalves (30), pneumatic system electrovalves (31), cabin gas analyzers (32), cabin temperature and relative humidity sensors (33), fin load cells (34), inclinometers (35) and computers (36), flag means being established on the control board (37) where the boat steering-wheel (42), boat speed and depth regulation levers (43) and (44) and the necessary navigation accessories, such as radio systems (38), video systems (39), satellite position system (40) and sounder (41), are also found. 10 15 20

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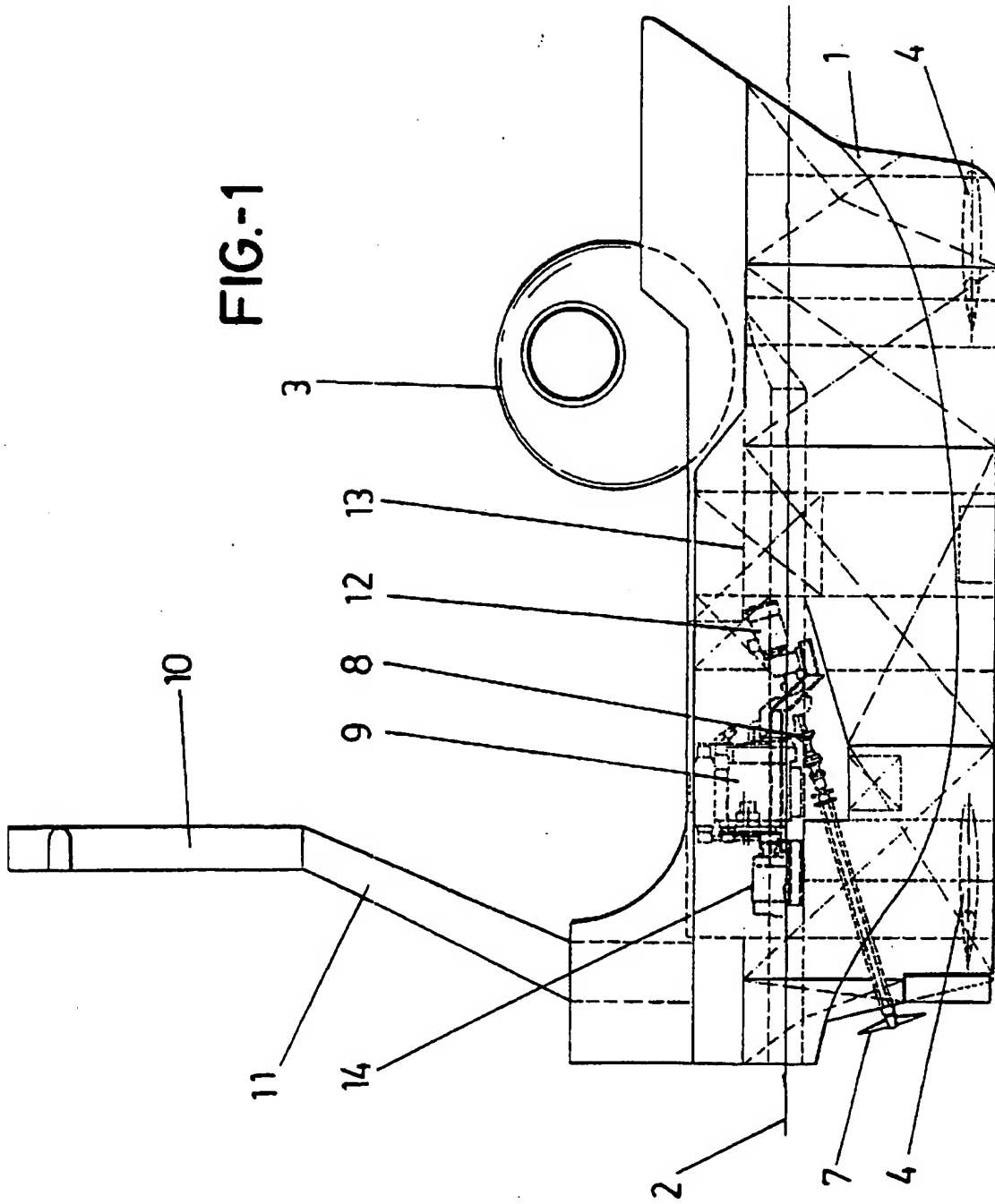
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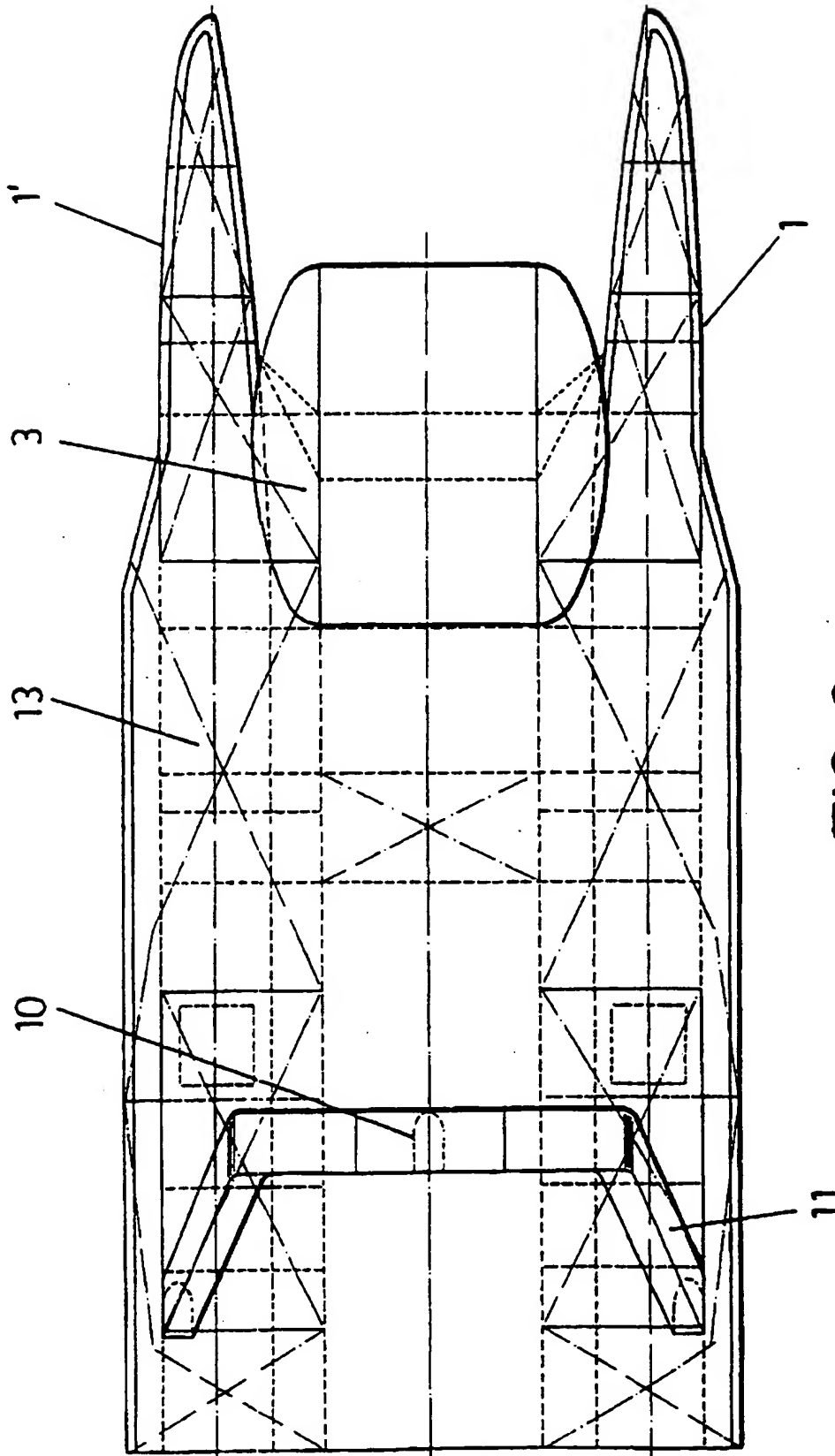
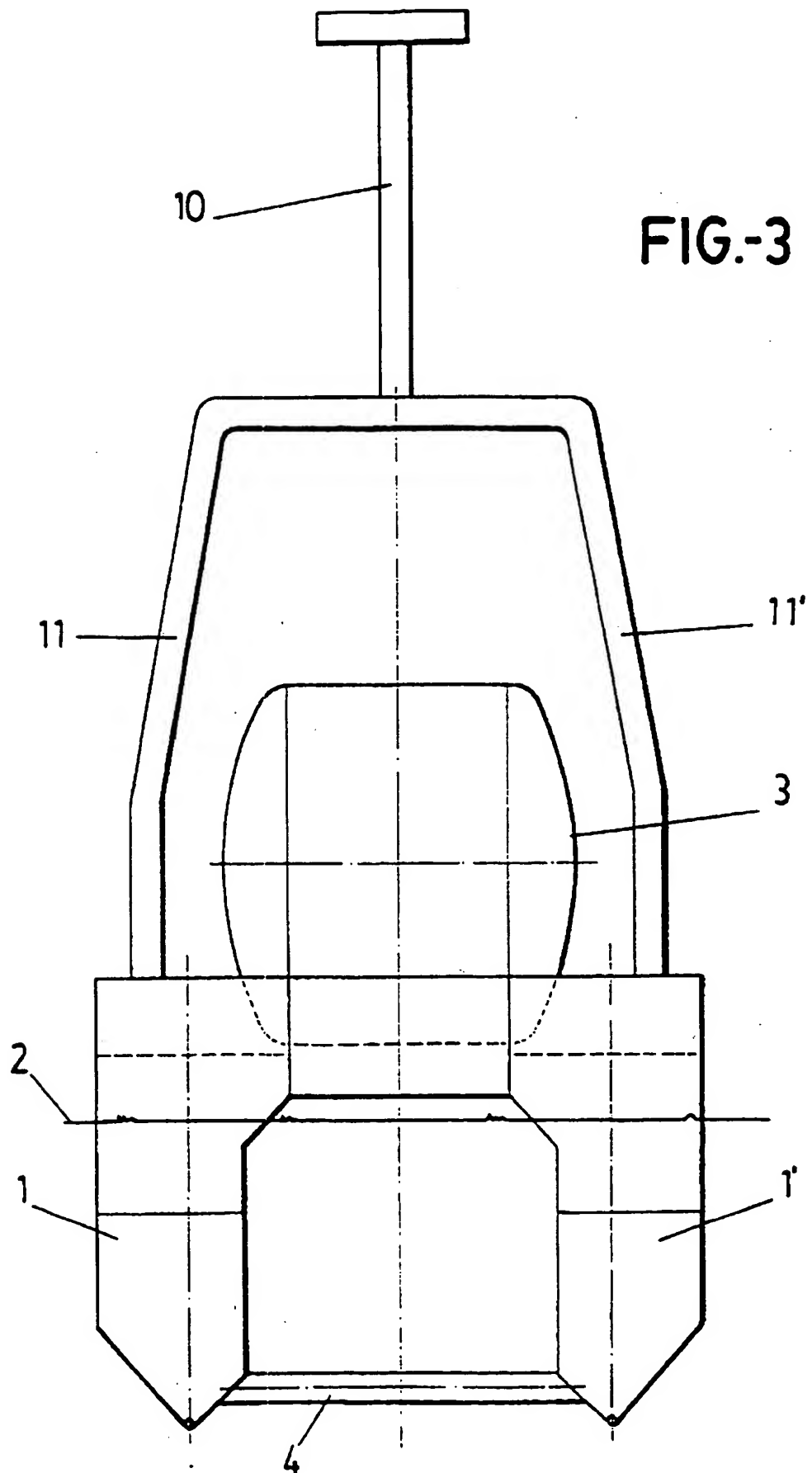


FIG.-2





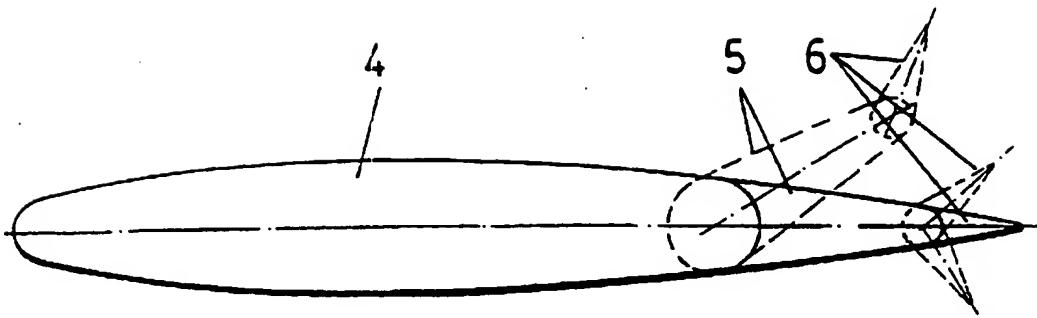


FIG.-4

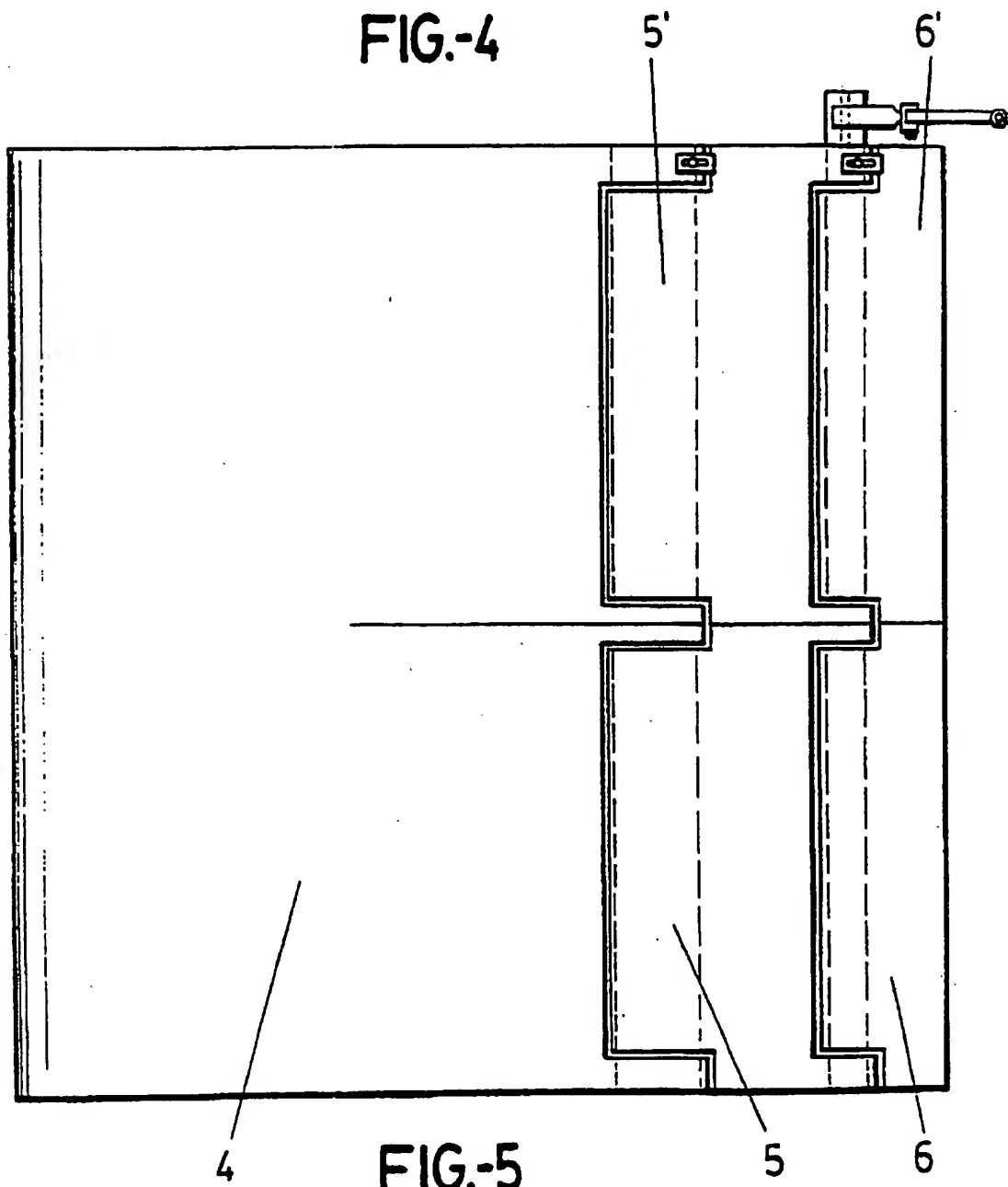
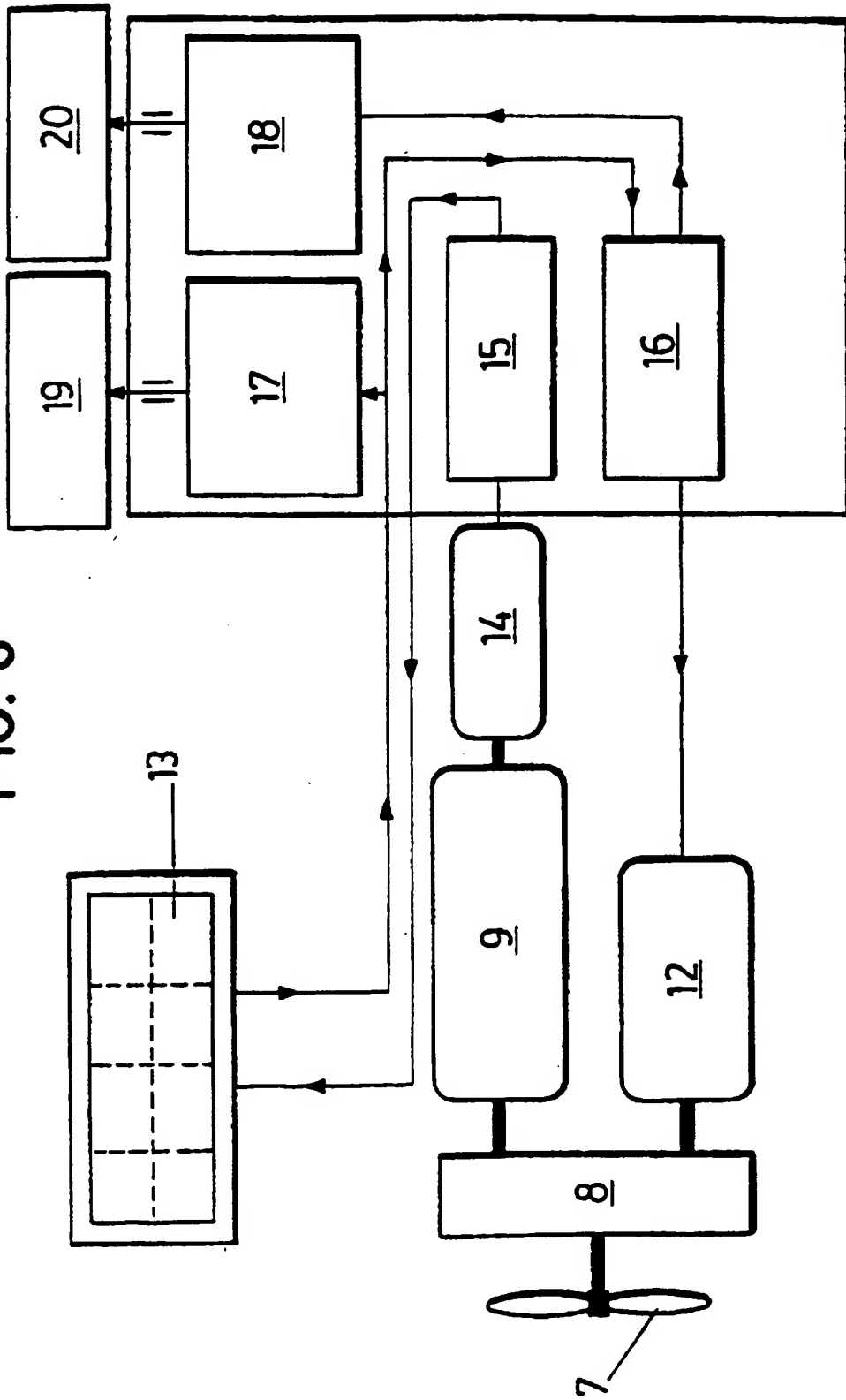
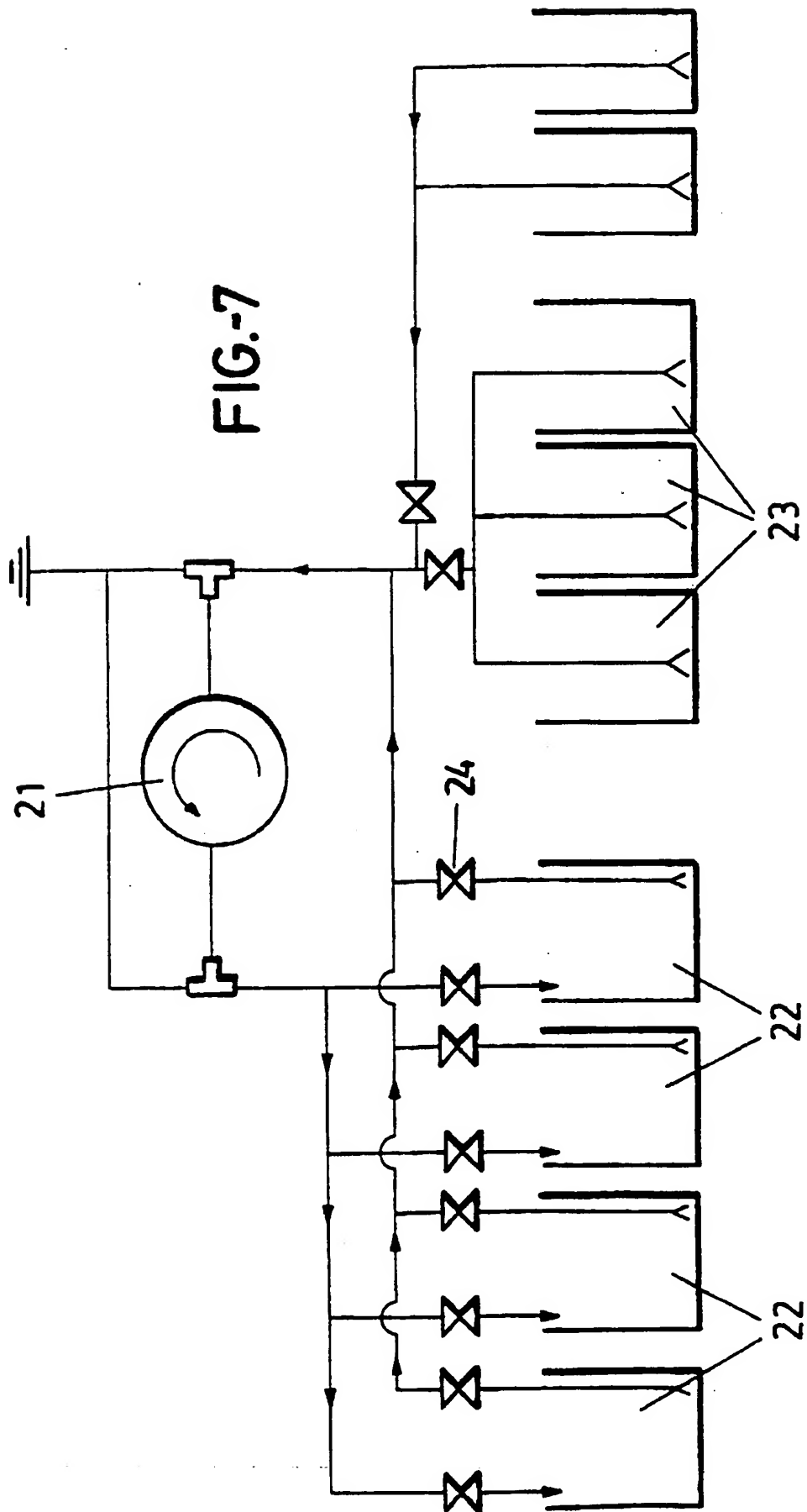


FIG.-5

FIG.-6





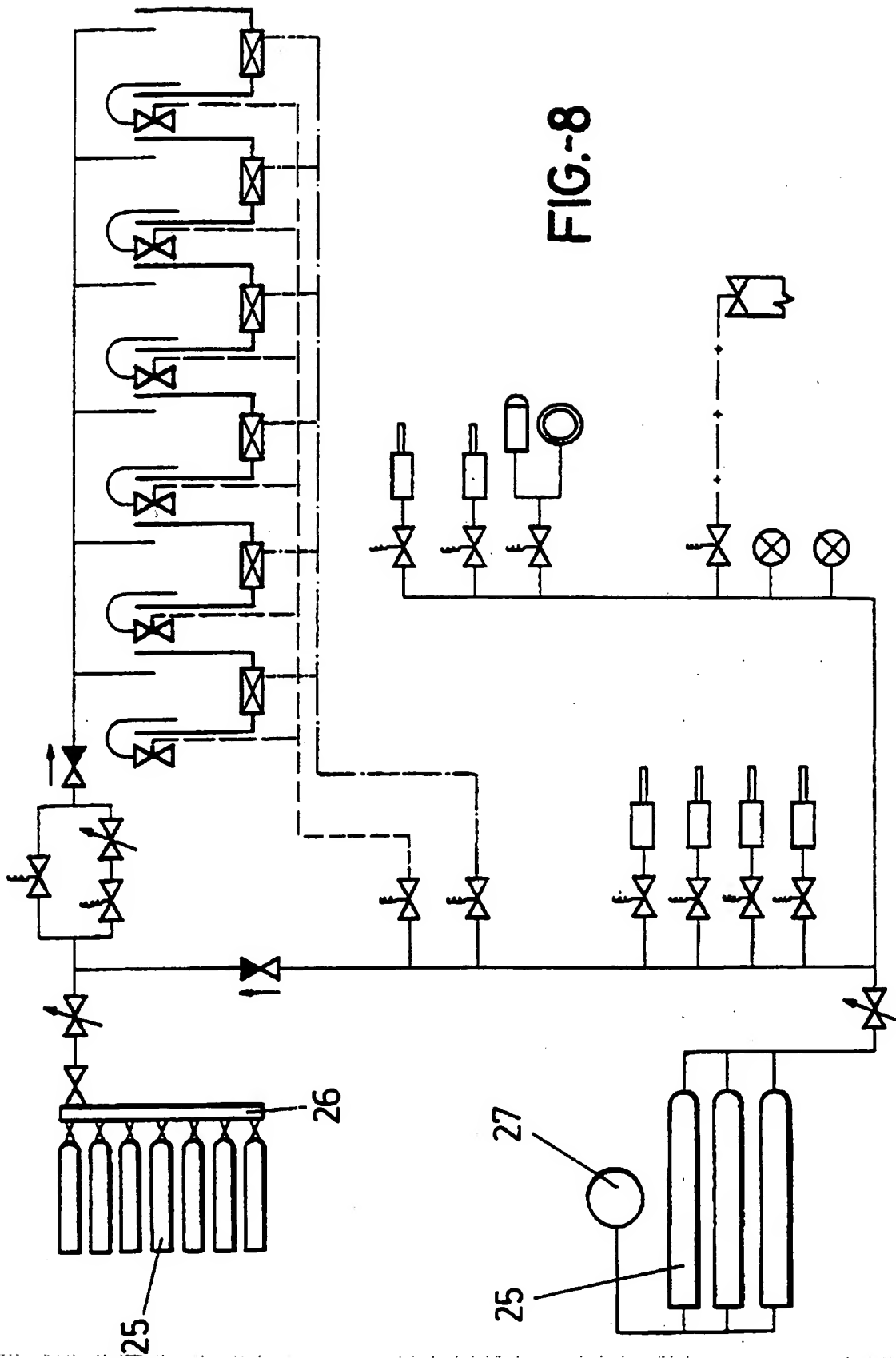


FIG.-8

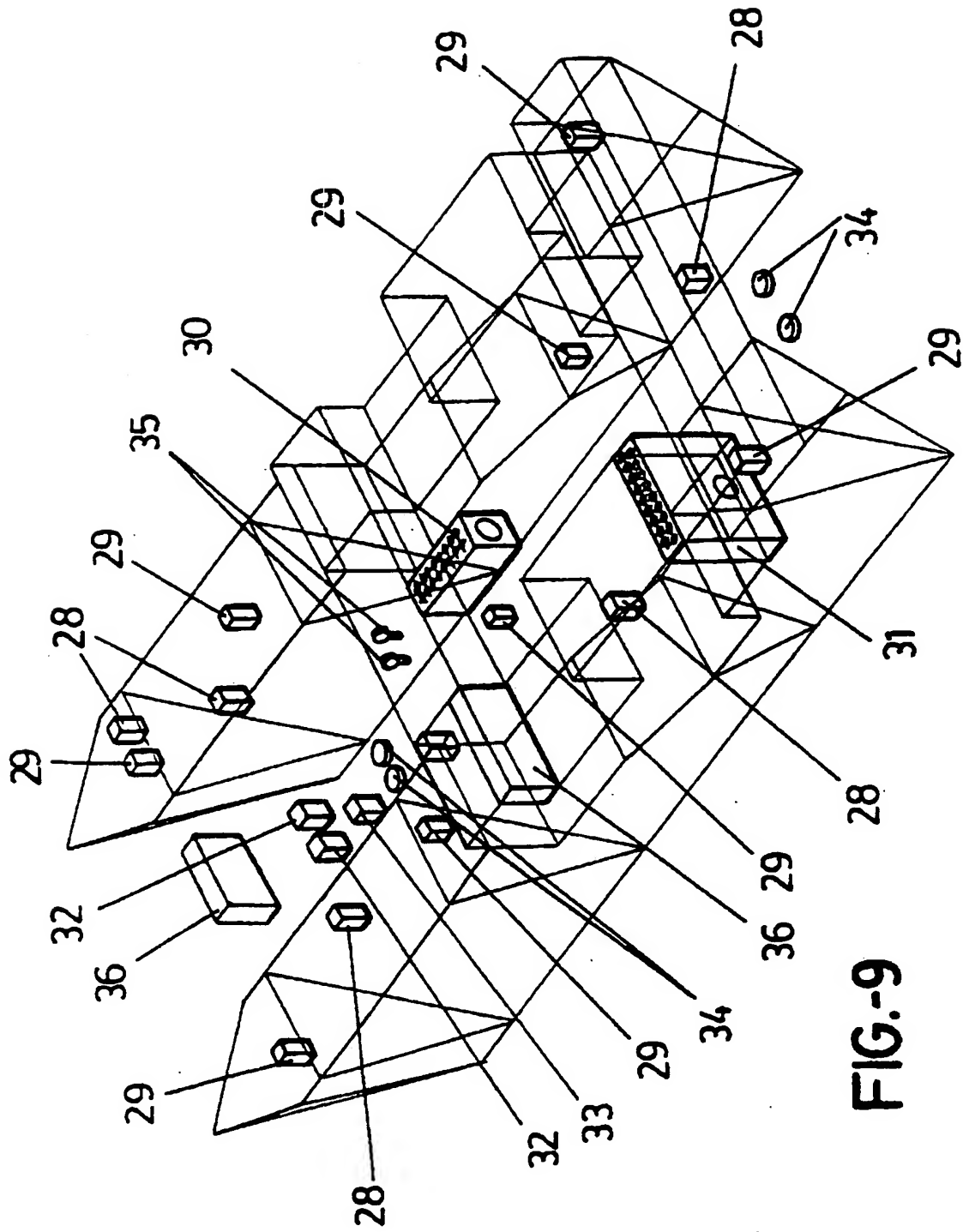
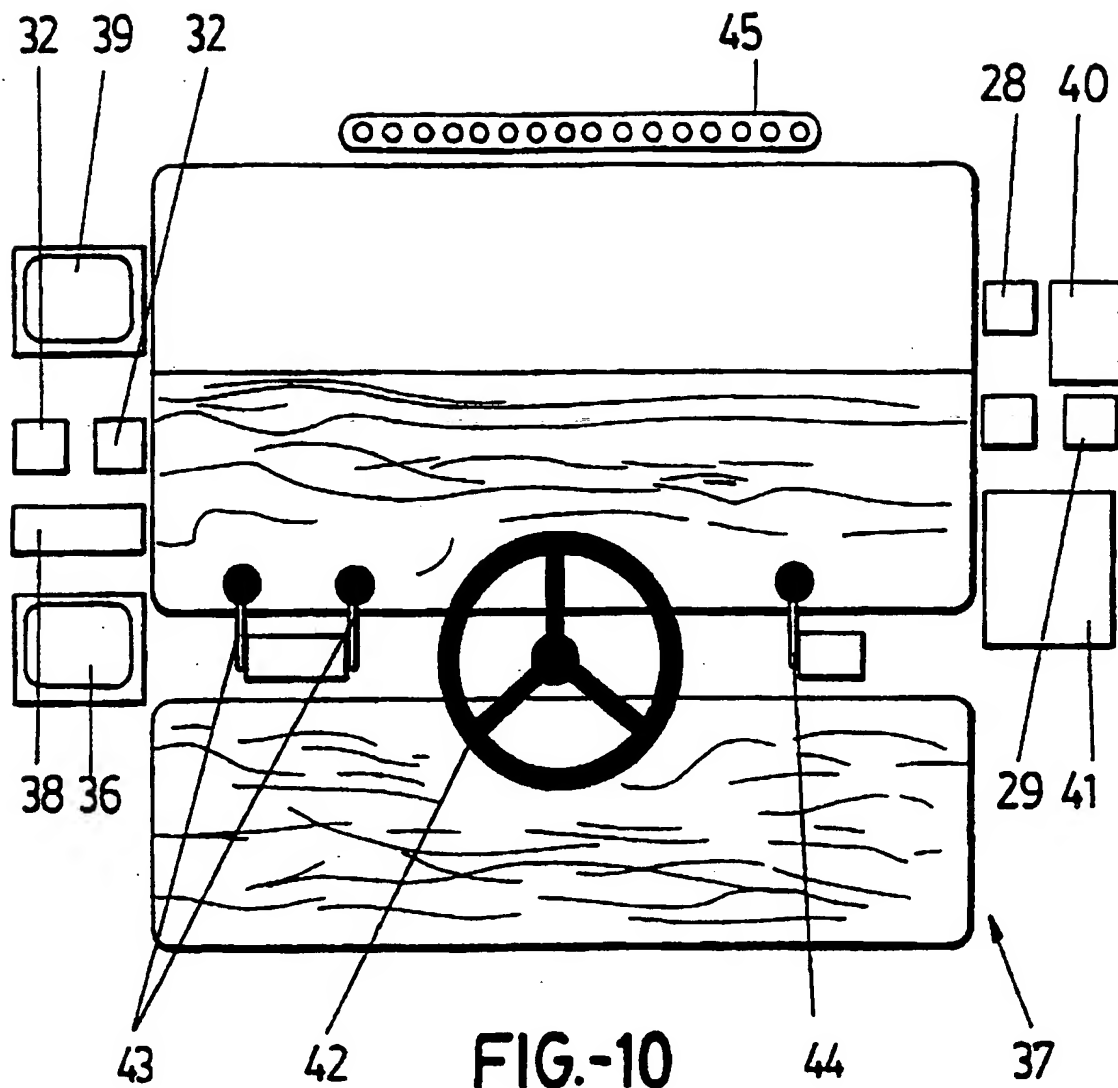


FIG.-9



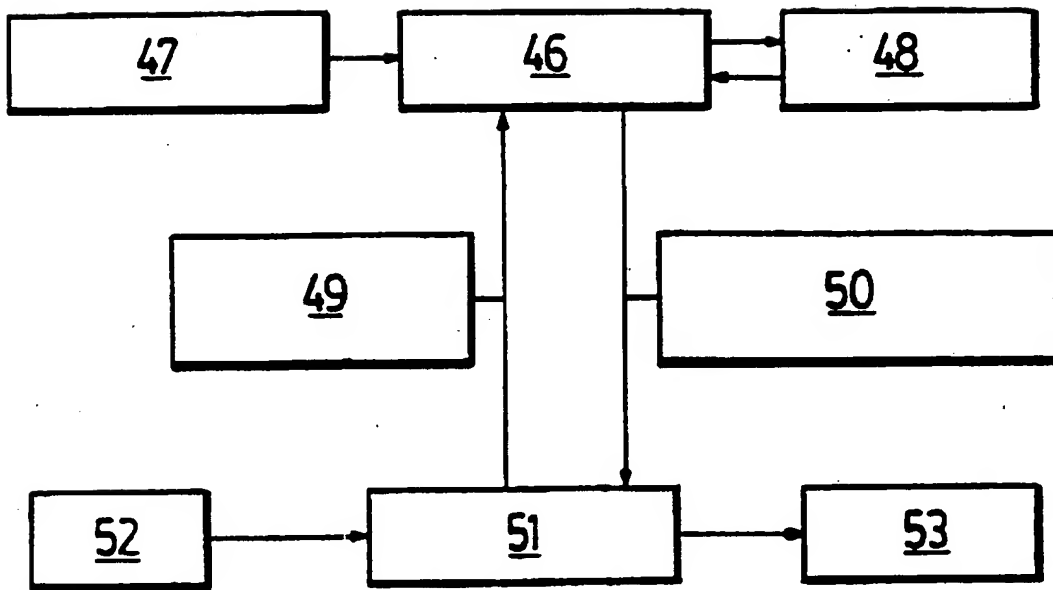


FIG.-11